Investigation of Development and Hydrodynamic Characteristics of Karst Systems Using Analysis of Hydrograph Recession Curve, Case Study: Karstic Aquifers of Alvand Basin

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Extanded Abstract

Introduction

Hydrograph of springs represents clearly all physical processes that control ground water flows inside aquifer (Kuto et al., 2012: 41). Study of the curve can reveal information about structure and function of aquifer, particularly hydrodynamic parameters including permeability and storage (Troch et al., 1993: 228). Analysis of recession curve has the advantage to calculate parameters of drainage mechanism such as recession coefficients. The volume of the primary discharge is sum of rapid and base flows and the specification of sub-regimes (Malık and Vojtkova, 2012). Identification of base flow properties and its prediction in dry period is necessary to determine the storage and to prevent it from pollution (Dewandel et al., 2003). Karstic aquifers are an enormous reservoir of water in many regions of the world and with decline in quality and the amount of alluvial aquifers they got important more as a strategic hoard of water (Suta, 2008: 856). The karstic aquifers are the main source of water for human society and ecosystem of Alvand Basin. They also provide the base flow of Alvand and are important in initiation and continuation of civilization in this basin. The purpose of the study is to assess the development of karst in the aquifers of Alvand using the analysis of recession curve hydrograph.

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Materials and Methods

The methodology of this research is based upon literature evidence, field work data and analysis of the recession curve hydrograph. Thus, we have used qualitative and quantitative data from hydrographic and precipitation stations of Power Ministry from 1999 to 2010. Coefficient of variations of the springs’ discharge (CV), the quality of water in the aquifers, and the hydrochemical parameters has been analyzed. Given the unequal development of karst in different parts of the aquifer, five springs (aquifers) have been selected to assess development of karst. These aquifers are including Rijab, Marab, Gelin, Sarab Garm and Gelodareh. To specify the type of flow system in karstic aquifers, hydrograph of recession curve have been analyzed. In order to calculate sub-regimes of laminar and turbulent flow, equations 1 and 2, respectively have also been used. Equation 1 is an exponential function that was suggested for laminar flows by Froccoyatsh and Palouk (1967). Equation 2 is linear function that was outlined by Kolmann for turbulent flows.

Equation 1: $Q_t=Q_0e^{-\alpha t}$

Equation 2: $Q_t=Q_0(1-\beta t)$

Results and discussions

The Rijab Spring has two laminar and turbulent sub-regimes. The equation of recession curve for this spring is as following: $Q_t = 2.1e^{-0.008t} + 1.25e^{-0.001t} + 510(1-0.29t)$. The degree of karstification of the Rijab aquifer is 5.5. There are also karstic channels in this aquifer. The rapid flow in Rijab aquifer is charged mainly by sinkholes and large cavities. The flow is also discharges by channels inside the aquifer. Sarabgarm Spring based on equation of recession curve of $Q_t = 2.01e^{-0.001t} + 1.25e^{-0.003t}$ has two sub-regimes and the karstification is 2.7. Golin Spring has two sub-regimes and recession curve as $Q_t = 0.62e^{-0.009t} + 0.46e^{-0.001t}$. Karstification is also about 3.7 with little channels. The equation is $Q_t = 0.263e^{-0.009t} + 0.175e^{-0.001t}$ for Gelodareh with two laminar sub-regimes and 3.7 karstification degree. There is just one flow regime (laminar) and many small channels. The equation is as $Q_t = 0.725e^{-0.002t} + 0.620e^{-0.008t} + 285(1-0.37t)$ for Marab spring. The equation indicates two laminar sub-regimes and a turbulent flow system with 5.5 karstification degree. In Marab aquifer turbulent flow is prevailing. The aquifer is charged by sinkholes and is discharged by channels inside aquifer.

Conclusion

Local differences in factors of karstification including lithology, tectonic, climate, elevation, slope and also physiographic characteristics of the drainage areas charging the aquifers in Alvand Basin cause variations in karstification and hydrodynamic behavior of aquifers. Analysis of rates of karstification, the values of Alpha, and also the number and the types of sub-regimes indicate heterogeneous karstic aquifers in Alvand Basin. Aquifers of Marab and Rijab are the most developed in karstification and Sarab Garm is the least in this terms. Geomorphology of surface terrain plays a major role in hydrodynamic behavior of aquifers. Physiography of the drainage basin where is charging the aquifers plays also a role in hydrodynamic characteristics and the quantity and kinds of sub-regimes. In high elevation areas, precipitation is more and evaporation is low. This cause more input into the aquifer that affect, in turn, the aquifer sub-regimes. Finally, this can be stated that three factors have the most importance in hydrodynamic properties and karstification of aquifers in Alvand Basin. These are geomorphology of surface karst, physiography of recharging basins, and elevation of the area.

Keywords: Alvand Basin, geomorphology, hydrograph recession curve, karstic aquifer, karst development.

Suggesting a Simple Criterion to Estimate Heavy Rainfall in Iran

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Extanded Abstract

Introduction

Selection of the clear and transparent index for the precipitation using long-term homogeneous data is an important point for the researchers. Several investigations have led to different indices for heavy rainfall. In some cases the specific amount of precipitation was used for heavy rainfall (Rahimzadeh, 2005; Masoodian, 2008; Kamiguchi et al., 2006), e.g. Alijani (2002) has suggested the precipitation more than 30 millimeter. Some investigators have used the percentage of daily precipitation as a heavy rainfall index (Mohammadi and Masoodian, 2010), e.g. Easterling et al. (2003) used the greatest annual 5-days total precipitation amount and the percentage of annual precipitation, due to all 24-h rainfall totals exceeding the 95th percentile of daily amounts. A series of international workshops have introduced a set of indicators to show the effect of climate change on extreme events (Folland et al., 1999; Nicholla and Murray, 1999; Manton et al., 2001). Some researchers used several indicators as an index for heavy rainfall (Seibert et al., 2005; Haylock et al., 2006; Haylock and Nicholis, 2000; Osborn and Hulme, 2002; Simonov et al., 2007; Vaidya and Kulkarni, 2007; Campins et al., 2006; Paddock et al., 2008; Kysely and Picek, 2007; Bukantis et al., 2010; Schmidli et al., 2002). For example, Hänsel and Matcshullat (2009) to study monthly trends of daily heavy precipitation indicators used 22 heavy precipitation indicators (HPI) that may be classified into the four groups “A”, “I”, “F” and “M”. “A” stands for average precipitation indicators like monthly precipitation totals and number of wet days. “I” comprises indicators measuring the precipitation intensity, like the SDPI (Simple Daily Precipitation Index) or the percentage of precipitation above the 95^{th} percentile. The frequency of heavy precipitation events is studied by indicators in class “F”, while category “M” includes indicators of heavy precipitation events magnitude. Zhang et al. (2001) proved that annual and seasonal time series of heavy event frequency are obtained by counting the number of exceedances per year. Characteristics of the intensity of heavy

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precipitation events are investigated by examining the 90th percentiles of daily precipitation, the annual maximum daily value, and the 20-yr return values. Based on the results, uses of percentile indicators are more common compared with threshold indicators and in some studies both the indicators have been used. It seems that the use of heavy rainfall partly depends on the geographical characteristics of the rainfall region. The natural ecosystems adapt themselves with the annual precipitation and extreme events in every region over time. Thus, the amount of precipitation shows the heavy rainfall in a dry station and in a humid station it can be recognized as normal. This study tries to find a simple method to indicate the heavy rainfall with regard to monthly trends based on daily data.

Methodology

To determine an index for heavy precipitation, data of daily precipitation for 40 stations with synchronized meteorological data are distributed homogeneously throughout the country in periods 1961-2011. The probability (1, 5, 10, 20 and 50%) for the entire period of rainy days was calculated using the Weibul equation. A very high percentage of daily precipitation values were obtained with the test 1 percentage, so the occurrence of five percent of daily precipitation was used as an index. The relationship between the ratio of the total mean annual precipitation (mm) and number of days with precipitation equal to or greater than one millimeter with a numerical coefficient may provide the best indicator for the heavy rainfall. Factor analysis of these two components can be selected from among the eleven factors of rainfall data including a total of 86 percent. Finally, the isohyet map was plotted using the numerical index by GIS so the heavy rainfall could be calculated for each part of Iran.

Results and Discussion

To determine the appropriate numerical factor in Iran, all the stations are classified into seven groups using K means cluster analyses, because of the different geographical characteristics and rainfall patterns. The average total annual rainfall was used to classify the groups. Then, the numerical coefficient was separately calculated for each group.

Conclusion

According to the proposed heavy rainfall index, the isohyet map was plotted. The isoline map of numerical coefficient was calculated for each station or related area in order to estimate heavy rainfall. The average error between the proposed index and the five percent probability of daily precipitation is 0.07. Only in Ardabil, Urumia, Dezful and Chabahar Port the error is more than one millimeter. There is no error in Ahvaz and Isfahan, i.e. the proposed index is equal to the five percent probability of daily precipitation. The comparison between the heavy rainfall isohyet map and the total average annual precipitation and the number of days with precipitation equal to or greater than one millimeter in Iran shows the same distribution.

Keywords: heavy rainfall, indicator, Iran, probability.

Application of Segmentation Methods to Recognition and Separation of Alluvial Fans in Yazd-Ardakan Basin

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Extanded Abstract

Introduction

This research addresses the automatic extraction of alluvial fans using four methods of segmentation from satellite data. This segmentation method divides images into partitions. It is typically used to recognize objects or other relevant purposes in digital images (Fu**,** 2013:3260). Alluvial fans have always been a landform that attracts human because they are suitable areas for living due to freshwater and appropriate soil for drinking, cultivation, making pottery, making mud-brick and other activities (Maghsoudi and Azizi, 2012: 23). Therefore, alluvial fan extraction is significant in the planning of engineering geomorphology and other related disciplines.

During the recent years, many segmentation techniques have been developed (Ranasinghe, 2008). In this research, the most popular segmentations are presented and then those that are appropriate to identification of alluvial fans of geomorphology were introduced. In general, land-surface segmentation has demonstrated to have a great potential to improve geomorphological mapping with better representations of geomorphological objects. Segmentation divides land-surface into relatively homogeneous areas, by polygons based on input criteria. Segmentation results are used to identify objects and their classification (Drăguţ et al., 2013). The main objective of this research is to introduce and implement algorithms for geomorphological landforms segmentations that the target landforms are alluvial fans and bahada in this research. The selected study area is in Yazd Basin and to test the ability for

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generalization of the selected methods, the similar alluvial fans of the central city of Yazd province have been selected. Briefly, importance of segmentations in geomorphology is in the extraction of landform objects, landform classification, landform isolation and identification details of landforms.

Methodology

The methodology of this study is based on processing segmentation on high-resolution images of Geoeye-1 as well as the ASTR-1 multispectral satellite images within the E-Cognition Developer© software from Trimble company. Arc Catalog and ArcGIS are used for production of the required layers in the proposed flowchart. In this study, two main approaches have been used in the construction segmentation. In the Top-down Segmentation, the objects of image are divided into smaller parts. Top-down approaches are approximately implemented by three algorithms: 1. Chessboard segmentation, 2. Quadtree-based segmentation, and 3. Contrast Split Segmentation. The forth method for segmentation is called multi-resolution segmentation that is the most popular method in the bottom-up segmentation approach (Baatz and Schäp, 2000).

We have described the four methods, and then each of those methods has been executed on the satellite images within the mentioned platforms. The outputs of each segmentation processing have been evaluated based on visual interpretation of the images. According to the flowchart proposed, outputs of segmentation have been separately overlapped on the high-resolution Geo-eye images that are used in ArcGIS environment. The existing map of geomorphology was used to improve visual interpretation. In this study, we used not only the top-down segmentation but also Bottom-up Segmentation approaches.

Results and Discussion

The segmentation results of the four methods in the E-Cognition Developer© software from Trimble company was as follows:

In short, the first method converts the image into a square shape that its output is a chessboard image. In the second method, the entire image is divided into four squares of the same size using the standard deviation or other criteria as a separate factor, and then each square is also divided into four smaller parts until to a defined threshold. These divisions continue until the objects are separated from each other based on shape and color homogeneity. This method will produce narrow strip initial segments for features with a large length-width ratio (e.g. roads, waterways, strip erosion types.), that is suitable for extraction of narrow objects in the context images. In the third method, the objects are separated by polygons from each other based on threshold values. This indicates the degree of difference between darkness and brightness. We were able to extract details of the alluvial fans (*e.g.* Shadow of gully erosion, oued,) using contrast segmentation method. The forth method, the image pixels or small objects are combined based on the criterion of homogeneity in successive with neighboring pixels or objects to lead to the production of larger objects. Therefore, the objects with homogeneous color and shape are combined to form a larger one. This technique is based on region growing concepts, in other words one or some known pixels are developed by the rest of unknown pixels based on a criterion.

Conclusion

On the basis of the results, it was concluded that two algorithms are popular and applicable in geomorphology: A) The multi-resolution algorithm is precise and high performance to identify the geometry of the alluvial fans of Yazd Basin; B) Contrast split segmentation has been successful to identify details on the body of the alluvial fans like to gully erosion, shadows, roads, Oued. Finally, in order to examine the testability of the selected methods, the multi-resolution algorithm has been executed in the similar fans in other parts of the central city of Yazd province. Its results have proved the generalizability of these methods, because the algorithm is repeated four times to identify and extract the boundaries of the alluvial fans, as the outputs appeared quite similar in the morphology of alluvial fan.

Keywords: alluvial fan, recognition, segmentation, Yazd.

Statistical Post-Processing of the Precipitation Output of RegCM4 Model, Northwest Iran

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Extanded Abstract

Introduction
The main perspective in seasonal prediction of precipitation is presentation of a qualitative prediction for upcoming seasons. The information gained from such predictions can be used for decision making in various disciplines such as agriculture, water management and hydropower production. Besides, it can help us reduce the adverse effects of climatic changes like drought and flood. But General Ciculation Models (GCMs) outputs have coarse resolution (>100 km). Dynamic downscaling is a method to obtain high-resolution climate data from relatively coarse resolution global climate models which do not capture the effects of local and regional forcing in areas of complex surface physiography. GCMs outputs at spatial resolution of 150-300 km are unable to resolve important sub-grid scale features such as clouds and topography. Many impact models require information at scales of 50 km or less. Several statistical and dynamical methods are developed to estimate the smaller-scale information. Dynamical downscaling uses a limited area, high resolution model (a regional climate model: RCM) driven by boundary conditions from a GCM to derive smaller scale information.

Methodology
The aim of this study was application of RegCM4 dynamic model (Reginal climate model) in forecasting rainfall and improving the outputs using post processing techniques in northwest

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Iran during period 1982-2011. The recorded data of precipitation were collected from Urmia, Tabriz, Ardebil and Khuy Stations. The data required for running the regional climate model RegCM4 were obtained from center ICTP (International Centre for Theoretical Physics), in the format of NetCDF including three sets of weather data, NNRP1 with a 6-hour-scale and a horizontal resolution of 2.5×2.5 on the reanalysis databases of National Center of environmental prediction of United States, sea surface temperature, (SST) with a horizontal resolution of 1×1 from the type of SST belonged to America and National Oceanic and Atmospheric surface SURFACE, which were consisted of three topographic data of GTOPO, the vegetation or land use, GLCC, and the soil type data GLZB, with a horizontal resolution of 30×30 seconds from United States Geological Survey. These data were organized for the period 1982 to 2011. In order to execute the dynamic model, a test was conducted to determine the Convective Precipitation scheme and the amount of horizontal resolution for the year 2009 (as a normal year). Accordingly, Kuo scheme with minimum mean bias error (MBE), in comparison with the observed precipitation in 36 synoptic stations of the region, was implemented as the main scheme with horizontal resolution of 30 × 30 square kilometers. The number of grid points including 152 in longitude (iy) and 168 in latitude (ix) was conducted during the statistical period of 1982 to 2011. Geographical area center implemented in the intended period was located in 30.5 degrees north latitude and 50 degrees east longitude. The output of the model included atmospheric data (ATM), surface cover (SRF) and radiation cover with the format of NetCDF, each containing a large number of meteorological variables among which, except precipitation from the Model (tpr), 9 variables that were associated more with precipitation were extracted. These variables are including q2m and t2m, ps, v1000, v500, u1000, u500, omega1000, omega500. For post-processing the output of the model we used the Multi-Layer Perceptron (MLP) and Moving Average (MA) methods. For MLP Entering variables were those 10 aforementioned and the target variable was observatory precipitation in the stationary point. At any one time, 80% of the data at the beginning of the series were for train and final 20 percent of data was used for test.

Results and Discussion

The results of the study demonstrated that, in the study area, the mean bias error of raw annual precipitation outputs of the RegCM4 model was 124.3 mm in the validation period, which by conducting Post Processing it was reduced to 8.9 mm. In the seasonal and monthly time scales, also, mean bias error were 31.1 and 10.4 mm, respectively, which were reduced to -0.3 and zero mm, respectively, after post processing. The MA model was the preferred post processing method, in all time scales.

Conclusion

In conclusion, it can be stated that the RegCM4 regional climate model with the implementing conditions and in the study area, contained mainly overestimate in precipitation forecasting. However, the application of post-processing will optimally reduce bias. The appropriate method is also the simple moving average (MA) method.

Keywords: ***convective precipitation scheme, dynamical downscaling, MA, MLP, post-processing.***

Extraction and Analysis of Synoptic Patterns Resulting in Thunderstorm in Ardabil Plain

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Extanded Abstract

Introduction

Thunderstorms pose a significant threat to modern societies and their assets. Despite their local-scale characteristics, severe thunderstorms and associated extreme events like heavy rainfall, hail, gusts, or tornadoes can cause considerable damage to agriculture, buildings, or infrastructure, and facilities. Thunderstorms are highly localized and largely stationary weather systems. They affect a limited area of about 20–50 km2, depending on the size of the cumulus tower. They are associated with shower clouds in which electrical discharges can be seen as lightening and heard as thunder on the ground. They represent an advanced stage in the development of convection in moist air. The importance of the rainfall generated by the thunderstorms lies in the fact that it is largely torrential and of high intensity, and as a result much is lost as runoff which causes flooding. Basically thunderstorms occur more frequently above land areas in the warm season, while they are more frequent in the cold season over oceans. A lot of factors impact their occurrence. Among them the most important are the thermodynamic and kinematic states of the atmosphere, topography, land cover, and its coastal configuration and atmospheric circulation conditions. Ardabil is located in the northwest part of Iran, for this reason it has always been under the influence of the thunderstorms. Due to the geographic location and specific local conditions in this region, every year numerous thunderstorm events happen in this area and cause severe damages to the agriculture, utilities and infrastructure sectors. From this point of view, studying this phenomenon in detail and identifying the synoptic patterns of the ground surface and upper levels in which they are formed in Ardebil are vital and important for the region.

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Methodology

For this study, initially the related data of Ardabil thunderstorms had been received from the Meteorological Agency of Ardabil. Within the related codes with the thunderstorms, codes from 90 to 99 during the period of 20 years (from 1992 to 2012) were used. After the initial Ardabil thunderstorm's data analysis, the 88 observational days that thunderstorm occurred in were identified, and out of the 88 days, the 43 days that were compatible with the observational hours of the NOAA data (3: 30, 9: 30, 15, 30, 21, 30) were used for the patterning. This is so that this research does not have any time contradiction with the upper atmosphere data and to be justified with the interpretation and analysis. Then, for the patterning and extraction of patterns in the upper atmosphere and ground surface, the related data to the pressure of the ground surface and geopotential height were obtained from the site which belongs to the National Center for Environmental Prediction (NCEP). Thus, to do this research, the environmental to circulation method was used. In this case, based on the recorded data in the Ardabil station, the occurred thunderstorms were identified and then by using the clustering, extraction and identification of the patterns were performed for the ground surface and upper atmosphere. For the classification and extraction of the ground surface pressure patterns and geo-potential height with the level of 500 hpa, the diverse kinds of hierarchical clustering methods were tested. Finally, based on the results, the clustering method into the Euclidean distance was known as the best method and the results of that were reflected in the following research.

Result and Discussion

According to the results of hierarchical clustering, 4 patterns on the ground surface and in the level of 500 hpa were identified. The extracted patterns could justify beautifully the Ardabil thunderstorm occurrence. The ground surface patterns that lead to the occurrence of thunderstorms are pattern 1: the formation of low pressure on India, Siberia and high pressure on northern Europe and west China; pattern 2: formation of low pressure on the Ganges Valley, Persian Gulf and North Europe and high pressure on Siberia and west China; pattern 3: formation of low pressure on India and Persian Gulf and high pressure on Siberia and west China; pattern 4: formation of high-pressure on the Central Asia and front occurring in the northwest part of Iran. The patterns of geo-potential height with the level of 500 hpa that lead to the occurrence of thunderstorms also are pattern 1: formation of the trough on the east Mediterranean and the placement of Ardabil in east part of trough; pattern 2: formation of the omega blocking on the northern parts of the Caspian sea and placement on Ardabil in southwest part of that; pattern 3: the occurrence of the cut-off blocking with low pressure over the central and east part of Turkey and its placement on Ardabil in east part of the trough made by that; and pattern 4: the occurrence of split flow blocking in central Europe and its placement over Ardabil in east part of the trough.

Conclusion

According to the results of hierarchical clustering in the ground surface and in upper atmosphere, there are different patterns effective on Ardabil thunderstorm precipitation. In the ground surface, formation of low pressure on the Ganges valley, southwest Persian Gulf, Siberia and northern Europe, also high pressure on the northern Europe, Siberia, west China and the

Central Asia played a significant role in the thunder precipitation events. On the other hand, in upper atmosphere, the study area in the east part of trough and the formation of different patterns of blocking (omega, Split flow and cut-off low pressure) provided the condition for occurrence of the thunder precipitation in Ardabil.

Keywords*:*Ardabil Plain, hierarchical clustering, synoptic patterns, thunderstorm.

Spatiotemporal Variations of Cold Period Precipitation in Iran (1950-2009)

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Extanded Abstract

Introduction

Precipitation plays an important role in the global energy and water cycle. It is important for assessment and management of land use, agriculture and hydrology such as flood and drought risk reduction to know about the amount of precipitation reaching the ground water. Assessment of climate change and its effects require long-term rainfall analysis in all spatial scales. Growing concern in the scientific community (Nicholls and Alexander, 2007) is about whether there is a significant change in the amount of precipitation?. About 29% reduction in the daily maximum water flow caused higher temperatures and increased evaporation with any change in rainfall causing drought in southern Canada during the years 1847 to 1996 (Zhang, Harvey, Hogg and Yuzyk, 2001). Recently summer drought caused by unusually dry heating in the areas related to tropical West Pacific and Indian Ocean (Andreadis, Clark, Wood, Hamletand and Lettenmaier, 2005; Pagano and Garen, 2005) including studies of climate change on global precipitation regimes. Germer (2008) has examined monthly variations in rainfall, floods, droughts and runoff in the Yangtze River Basin in China. In another study, Dao (2004) studied the daily variation of rainfall in semi-arid regions of northern China. Raziyy and Azizi (2008) said that topography and latitude are main factors of controlling the precipitation in the west part of Iran. Also, Asakereh (1386) has investigated spatiotemporal variation in Iran precipitation. The results of their study indicated that about 51.4% of rainfall areas in Iran have been changed. In this context, the author aims to explore the development of spatiotemporal changes of the rainfall pattern with access to the available and reliable database and the new approach to

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extract patterns and possible trends in the data. This paper investigated the spatial patterns of precipitation amount trends in cold period of year, for Iran between 1950 and 2009.

Methodology

We used reanalysis of monthly data of GPCC with 0.5*0.5 spatial resolution in Iran (From 44E until 63.5E and 25N until 40N) and global & local Moran's spatial autocorrelation methods. Global Precipitation Climatology Center data accuracy is measured by the geographical weighted regression (GWR) method. Spatial autocorrelation of precipitation data were extracted by global Moran Index. This index shows only the overall clustering of precipitation data. Therefore, to detect the different local patterns spatial autocorrelation, local Moran was used. The index measured spatial differences in rainfall amounts between each grid point and its neighboring points and evaluated its significant level. Trend analysis of the spatial patterns was configured based on Man Kendall's τ nonparametric test.

Results and Discussion

Geographically weighted regression between the global climatology center data and station data showed that the gridded data have verified to be acceptable to be replaced by the station data. Rainfall Gridded data and station data indicated an average correlation of 76%. Global spatial autocorrelation results and precipitation data in all of the months indicate significant positive spatial autocorrelation (or clustered pattern). Local spatial autocorrelation results of each month show proprietary precipitation pattern and monthly precipitation. They entailed any significant trends. October shows the lowest average index values and dispersion in rainfall patterns. Unlike the months of December rainfall patterns have shown concerted. A spatial clustering map shows, usually in October, a strong spatial cluster is formed on the southern coast of the Caspian Sea. However, during the months of November and December, a strong spatial cluster formed in Zagros on rain again. In February and March the Caspian cluster is reduced in proportion severity.

Conclusion

Temporal variations of the No, high - high points and No, low-low points in all months indicated no significant change. This suggests a lack of space to expand or reduce the size of the cluster rainfall during the study period and comparison between pervasive drought events. Low value of Global Moran's Index indicates a strong relationship between them. Thus, it is required to be used for other variables for water defect researches.

Comparing of general Moran index values and widespread drought in Iran showed that the low index values are based on the years of drought. The results of this research suggest that the evidence of dehydration in other climatic variables such as temperature and evaporation.

Keywords:* *Exploratory Spatial Data Analysis (ESDA), Iran, Moran's spatial autocorrelation, spatiotemporal distribution.

Evaluation of the Effects of Land Use Change from Forest Areas into Agricultural Lands on Some Chemical Properties of Soil (Case Study: Zarin Abad, Sari, Iran)

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Introduction

Land use change and its effects on soils is one of the important factors that decrease soil quality. Nowadays because of rapid growth of population, vast forest areas are changed into agricultural lands but chemical properties of the soils are commonly affected by changes in land usage. Converting the forest areas into agricultural lands is one of the prevalent issues in Iran, especially in north Iran. Nevertheless, relevant studies about the effects of land use change are very limited and lack of enough and suitable studies due to quantifying of these effects is so significant. Because of that, this study was carried out to investigate the impact of changes in usage of forest lands into the dry farming lands (canola) and paddy lands on some chemical properties of soil such as: pH, organic carbon, total nitrogen, available phosphorous and potassium, electrical conductivity and cation exchanging capacity in Zarin Abad area of Sari, in northern Iran.

Methodology

In order to study the effects of changes in usage of forest lands (Hyrcanian forest) into the dry

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farm lands (canola) and paddy lands on some chemical properties of soil in Zarin Abad area of Sari, this research was conducted in factorial design in complete randomized block. The samples of soil from each land use were collected in four replications from 2 depths of 0-20 and 20-50 centimeter. The samples were dried and passed from the 2mm sieve, and then the organic carbon was determined by the method of wet oxidation. Total nitrogen of the soil was measured by Kejeldal method. To calculate the soil available phosphorous, the samples were extracted in two ways: Olson (for measuring available phosphorous in soil samples with pH=7) and Bray-Kortz (for measuring available phosphorous in soil samples with pH=7). Then, the amount of phosphorous in each extraction was determined with Expectrophotometer device. Available potassium was measured by extraction with Ammonium acetate with pH=7 and Flame photometer device. Cation Exchanging Capacity was also determined by Bawer method. To measure the reaction and the electrical conductivity of the soil samples, after making saturation mud, the amount of reaction (pH) was measured by pH meter in each sample. The amount of electrical conductivity after extracting from saturation mud was determined in extractions from each sample by Ec meter. Then, the analysis of data was done after performing normalization test with Colomogrof-Smirnof test in SPSS application. Comparison of the averages of data was done with Duncan test.

Results and Discussion

Results showed that land use change from forest lands (Hyrcanian forest) into paddy lands, increased soil reaction from 6.43 to 7.52 but change to dry farming lands (canola) had no significant effect on soil reaction. Land use change from forest lands into dry farm lands caused decrease in the amount of organic carbon about 46.5 percent. This was about 38 percent in paddy lands. The amount of total nitrogen was decreased in land use change from forest usage into dry farm usage but this decrease was not significant in forest lands into paddy lands. Although land use change caused increase about 4 times in the amount of available phosphorus in dry farming lands and increase about 2 times in the areas converted into paddy lands, it had no effects on the amount of available potassium and cation exchanging capacity. The lowest amount of electrical conductivity was observed in dry farming lands. Correlation coefficients between the parameters showed positive and significant correlations between organic carbon with available potassium and electrical conductivity. There were positive correlations between electrical conductivity with the amount of available potassium and soil reaction. The amount of available phosphorus also showed a positive relationship with cation exchanging capacity.

Conclusion

Land use change caused transformations in some soil chemical properties and each property affected the values of other properties. Given the ecological importance of northern forests of Iran, the results of this study showed the necessity of more accuracy and attention to adjust the unfavorable effects of land use change by applying efficient methods of land management in these areas.

Keywords: dry farming, forest, land use change, organic carbon, paddy lands.

Analysis of Spatial Patterns of Monthly Precipitation in West and Northwest Iran Using Spatial Autocorrelation

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Extanded Abstract

Introduction

Precipitation is a vital component in the hydrological cycle. Its spatio-temporal variations have great environmental and socioeconomic impacts. The spatial variation of rainfall depends upon many factors. Some of these variations are due to synaptic systems and some others formed by local physiographical characteristics of stations such as elevation from sea level, slope, windward and leeward slopes, land cover and land use and etc. If the rainfall is formed by widespread and pervasive synoptic system, it can show a significant spatial similarity and homogeneity in the amount of a given rainfall in all over the region. This is affected by synoptic system. But if the rainfall is dominated by local factors the higher heterogeneity of given amount of the rainfall can be expected.

Methodology

In this study, we used 20-years monthly average precipitation (1990-2010) for 42 synoptic stations, in the west and north western portion of Iran. These include 6 provinces namely: the East and West Azerbaijan, Kurdistan, Ilam, Kermanshah, Hamadan and Zanjan. We prepared these data as long term average of monthly precipitation for each station and then import them into GIS by metric projected coordinate system (PCS). We used Moran,s Index as an spatial statistic approach to investigate the spatial relations of monthly precipitation. This tool measures spatial autocorrelation (feature similarity) based on both feature locations and feature values simultaneously. Given a set of features and an associated attribute, it evaluates whether the pattern expressed is clustered, dispersed, or random. The tool calculates the Moran's I Index

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value and both a Z score and p-value evaluating the significance of that index. In general, a Moran's Index value near +1.0 indicates clustering while an index value near -1.0 indicates dispersion. However, without looking at statistical significance you have no basis for knowing if the observed pattern is just one of many, many possible versions of random. In the case of the Spatial Autocorrelation tool, the null hypothesis states that "there is no spatial clustering of the values associated with the geographic features in the study area". When the p-value is small and the absolute value of the Z score is large enough that it falls outside the desired confidence level, the null hypothesis can be rejected. If the index value is greater than 0, the set of features exhibits a clustered pattern. If the value is less than 0, the set of features exhibits a dispersed pattern.
The Morans I Statisic for spatial autocorrelation is given as

1. Moran index
2.

$$I = \frac{n}{S_0} \frac{\sum_i \sum_j w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_i (x_i - \overline{x})^2}$$

where, Zi is the deviation of an attribute for feature I from its mean, wij is the spatial weight between feature i and j, n is total number of object and S0 is aggregate of spatial weight.

Results and Discussion

We found that the amount of monthly rainfall in the study region in cool season (November to February) has a significant positive autocorrelation. On the other hand, the spatial variation coefficient of rainfall in these months is smaller than other remaining month. The revealed Moran’s I indicated the 4 mentioned months so strong significance that this spatial homogeneity cannot be considered by chance and randomness. In the cool season, the study area located in west and northwestern Iran is dominated by westerlies and following them the atmospheric synoptic systems entrance to country affect all of the country area. Then, the rainfall formed by widespread and pervasive synoptic systems has significantly spatial similarity and homogeneity in all over the region and the strong positive autocorrelation is revealed in these months. In the warm season (July, September, August, October, and May) we find inverse condition. The Moran’s index in these months was very small and near to zero. We couldn’t detect any significant spatial autocorrelation in these months. In our study region the warm season especially summer season (July to September) is the dry period of year. The occurred rainfall in these months is usually sporadic and non-comprehensive. These rainfalls are usually characterized by being showery. This is formed by local atmospheric convective cells. In this type of rainfall the different local physiographical characteristics such as elevation from sea level, slope, windward and leeward slopes, land cover and land use and etc. have a substantial roll in formation and spatial distribution of this rainfall.

Conclusion

The difference in physiographical characteristics of each region of this local formed precipitation is not very similar. In the warm season, one can see the absence of westerlies in

this region, the local physiographical characteristics of the occurred rainfall due to this physiographical dissimilarity in the region, and heterogeneity of given amount rainfall. The spatial variation coefficient of rainfall in warm season is very higher than cool season. The revealed Moran's I was not significant in 0.95 confident levels and there are no spatial pattern. The findings of this research indicated that only the cool season months reveal a significant spatial autocorrelation in 0.95 and 0.91 confident levels.

Keywords: precipitation, spatial autocorrelation, spatial pattern, West and North West Iran.

Assessment of watershed Tectonics Using Geomorphologic Characteristics in the TecDEM Model, Roodak Basin in North East Tehran

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Extanded Abstract

Introduction

Identification of active tectonic areas, especially in convergent zone are very important because of their potential risks. Nowadays, there are several algorithms that are used for tectonic analysis; one of them is TecDEM that is used in this research. In this study, using Remote sensing techniques, geomorphometric analysis and fieldwork were conducted to analyze morphometric and geomorphologic characteristics of Roodak basin in northeast region of Tehran in the TecDEM model within Matlab software. This model used new indices such as Skewness and Kurtosis of hypsometry diagram, concavity and steepness indices and finally Isobase Map. The obtained results from this calculation represent morphotectonic changes on the watershed. The results in the TecDEM model in comparison with field studies. The obtained evidence through Garmabdar Geodynamic station data shows accuracy of the model at Description and Analysis neotectonic terms area.

Methodology

To investigate active tectonics in the study area, through geological map (Tehran, MarzanAbad, Baladeh, Fasham) of the area the faults zones was diagnosed. Then, evidence of active tectonics in the basin was studied by regional presence. The data analysis of Garmabdar geodynamic permanent station was used based on the data from 5 years (2006 to 2010). Then, through a Kartosat2.5 meter resolution satellite image approximate range of Roodak basin and sub basins were specified. Finally, to extract Roodak basin and sub-basins and calculate the indices, we used ArcGIS and TecDEM software by Digital Elevation Model (DEM).

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Results and Discussion

The values obtained from indices and field study and analysis of Garmabdar geodynamic station show that Roodak Basin is in early stage. The observations represented lack of sediment on some areas, fractured rocks by fault, steep slopes, narrow valleys and high mountains, high potential of mass movement in the basin. These were to some extent consistent with calculated tectonic indices. Thus, the TecDEM is a powerful tool to understand the nature of tectonic zones. Based on concavity and steepness and gradient slope river indices, fourth sub basin of Garmabdar basin has the highest rate of activity and Meygoon basin has the lowest rate of activity. Based on transverse topographic symmetry index, first and third sub basins show the maximum tilt. Furthermore, IsoBase map of the area confirms tectonic effects on topography changes and changes in the classification of stream basin. Hypsometry curves for all sub-basins show young terms in the Roodak Basin and its sub basins and fourth sub basins of Garmabdar has the most Convexity. Despite the difference in values of parameters, average values represent active tectonic regime in the basin. Accommodation of field study, library studies and geodynamic data with model results demonstrate the proper use of this model in tectonic analysis. Especially in relation to the areas that may not be possible to field study.

Conclusion

Roodak basin of geological division is part of Alborz-Azarbaijan seismotectonic. This basin is also in southern highland of central Alborz and much of it is green tuff of Karaj Formation. In terms of hydrology this basin is part of the Jajrood basin and the eastern branch of Jajrood River flows in that. The river originates from the highlands of Basatk and after passing through the Darbandsar and Shemshak, Meygoon and Fasham with Another branch is connected to Nika, Lalani Ruteh water tributaries called Jajrood. Ahar River from south and Amameh River from north are attached to it and create eastern Jajrood River. In this study, using remote sensing techniques, Geomorphometry analysis and fieldwork analyzed morphometric and geomorphologic characteristics for Roodak basin in northeast of Tehran in the TecDEM model within Matlab software. The analysis results of structural elements extracted by longitudinal profile of the river, flow directions, basin morphology, slope change, IsoBase map, geomorphic indices and Skewness and Kurtosis of hypsometry diagram is resulting from the interaction of tectonic forces. This represents morphotectonic changes on the watershed. The results of the TecDEM model in comparison with field studies and obtained evidence through Garmabdar Geodynamic station data show accuracy of model at Description and Analysis neotectonic. Thus, the TecDEM is a powerful tool to understand the nature of tectonic zones.

Keywords: morphotectonic, Roodak Basin, TecDEM Model, tectonic activity, Tectonic geomorphology.

Identification of Vulnerability Potential of Groundwater Quality in Birjand Plain using DRASTIC Model and its calibration using AHP

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Extanded Abstract

Introduction

Water is the most important parameter in the development of human societies. One of the pillars in the development of water resources is the investigation of environmental conditions and environmental compatibility of the project. Identification of the areas vulnerable to pollution can play a major role in development strategies. In most areas of Iran, located in the arid and semi-arid region, groundwater is the most important water supply for agricultural, domestic and industrial uses. In most areas, the risk of groundwater contamination is considered as a serious restriction for this source. Therefore, it is essential to avoid groundwater contamination in groundwater resources management. One of the methods to identify vulnerable areas is the use of qualitative indicators. Among the qualitative indicators, the DRASTIC index of vulnerability to groundwater pollution has many applications. This index is obtained by combining seven different parameters. Each of the parameters of the model investigates the potential and the possibility of accepting the contamination of the aquifer and each parameter has a unique weight. So far, most studies which have been done with this indicator have led to aquifer vulnerability mapping but model calibration and optimization of input coefficients is less studied. This study was conducted to investigate the vulnerability of Birjand aquifer and increase in the accuracy of the model.

Methodology

In this study, to estimate the vulnerability by contamination, different hydro-geological data

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were used. These data are including depth to water table, net recharge, aquifer environment, soil environment, topography, environment unsaturated and hydraulic conductivity. Then, plain vulnerability maps were computed using DRASTIC index with combination of these data. One of the most important and influential parameter in environmental contaminations is nitrate. In this project, in order to evaluate the vulnerability of the Birjand aquifer obtained by DRASTIC model, the observed data of nitrate in Birjand aquifer was tasted in 2011. According to the concentration of the Nitrate in the observation wells; the model was calibrated using Analytical Hierarchy Process (AHP). For this purpose, the parameters of the DRASTIC model, with respect to the inconsistency rate as stated, was modeled by AHP method using software provided by the Expert choice modeling. The calibration weight and then the analysis of these weights was done using the consistency coefficient.

Results and Discussion

DRASTIC layers were obtained using interpolation and classification tools in the ArcGIS 10.2 software. According to the preliminary results, depth to the water table and slope parameters has the highest weight in aquifer data.The recharge rate of the aquifer in two parts of urban areas, due to the recycled water, has higher weight than in other parts of the aquifer. According to drilling logs, influence testing, pedological testing and the aquifer environment are classified in two classes, the soil environment in four classes and unsaturated zone in tree classes. Given the high levels of recharge due to return flow, it was divided in urban areas and agricultural land according to the test results of pedological and hydraulic conductivity parameters in three classes. After obtaining the required parameters for vulnerability assessment, vulnerability map of the Birjand Aquifer was obtained using DRASTIC model. Incompatibility factor was chosen as one of the major constraints to optimize the coefficients and weights of DRASTIC model. Based on the obtained results and the value of using AHP method incompatibility factor of less than 0.08 is selected as the best option for analysis. The classification of Birjand aquifer vulnerability was presented based on DRASTIC with weight of AHP model. This includes four categories of very low, low, moderate and moderate to high. The results show the sensitivity of the aquifer in the outlets due to the high water table.

Conclusion

The results provided by the DRASTIC model showed that the model was not accurate enough to identify vulnerable areas and it is needed to calibrate the weights of models. Therefore, in this study using Analytical Hierarchy Process (AHP) and observational data of nitrate, the model was calibrated in the Birjand aquifer. The results indicated that the modified DRASTIC model has the higher accuracy in comparison with common DRASTIC model. There is also a good correlation between the improved weights using AHP method and the observed nitrate concentration in observation wells.

Keywords: AHP, calibration, correlation coefficient, DRASTIC, Vulnerability.